The Victorian Naturalist

Volume 131 (5) October 2014

Published by The Field Naturalists Club of Victoria *since 1884*

From the Editors

As often occurs, this issue of *The Victorian Naturalist* is relatively wide-ranging in the subject matter of its contents. This diversity of coverage is largely a function of the material accepted for publication in the journal; except in the case of 'special' issues, papers are generally gathered according to their order of acceptance. Notwithstanding, there is perhaps a slight bias in this issue toward the arthropods: a Contribution referring to dragonflies; a Naturalist Note on spiders; and a Book Review on butterflies.

The issue also includes a paper on the flora of the Cocoparra Ranges, which puts into print a record of changes that have occurred in local vegetation. Papers such as this are an important component of the role of this journal since they provide accessible bases for comparison with the results of future studies.

One of the books reviewed in this issue—Graham Patterson's *Coastal guide to nature and history*—recently received a Commendation in the 2014 Victorian Community History Awards. These awards are made annually under the aegis of the Public Record Office Victoria and the Royal Historical Society of Victoria. The Editors are pleased to congratulate the author, a fellow member of the FNCV.

The Victorian Naturalist
is published six times per year by the

Field Naturalists Club of Victoria Inc
Registered Office: FNCV, 1 Gardenia Street, Blackburn, Victoria 3130, Australia.
Postal Address: FNCV, PO Box 13, Blackburn, Victoria 3130, Australia.
Phone/Fax (03) 9877 9860; International Phone/Fax 61 3 9877 9860.
email: admin@fncv.org.au
www.fncv.org.au

Address correspondence to:
The Editors, *The Victorian Naturalist*, PO Box 13, Blackburn, Victoria 3130, Australia.
Phone: (03) 9877 9860. Email: vicnat@fncv.org.au

The opinions expressed in papers and book reviews published in *The Victorian Naturalist* are those of the authors and do not necessarily represent the views of the FNCV. Copyright of all original material published in *The Victorian Naturalist* remains with the author.

Yearly Subscription Rates – The Field Naturalists Club of Victoria Inc

(as of January 2014)

Membership category		Institutional	
Single	$79	Libraries and Institutions	
Concessional (pensioner/Senior)	$58	- within Australia	$152
Additional Concessional	$21	- overseas	AUD163
Family (at same address)	$100		
Junior	$32		
Additional junior (same family)	$16	Schools/Clubs	$89
Student	$32		

All subscription enquiries should be sent to:
FNCV, PO Box 13, Blackburn, Victoria 3130, Australia
(**N.B.** New postal address)
Phone 61 3 9877 9860. Fax 61 3 9877 9862. Email: admin@fncv.org.au

The Victorian Naturalist

MUSEUM VICTORIA
25 NOV 2014

Volume 131 (5) 2014 October

Editors: Anne Morton, Gary Presland, Maria Gibson

Editorial Assistant: Virgil Hubregtse

From the Editors 158

Research Report Does human exposure alter vocalisation rate in Little Penguin *Eudyptula minor*? *by C Scarpaci* 160

Contribution A limited vegetation survey of Cocoparra National Park and Cocoparra Nature Reserve, *by Eric Whiting* 162

Southern Riffle Darner *Notoaeschna sagittata* in the Bend of Islands, Victoria, *by Frank Pierce* 177

Book Reviews Butterflies: identification and life history *by Ross Field, reviewed by Michael Braby* 181

Coastal guide to nature and history: Port Phillip Bay *by Graham Patterson, reviewed by Eric Bird* 183

Naturalist Notes Handicapped spiders at Notting Hill, Victoria, *by Virgil Hubregtse* 184

Predation of a Common Scaly-foot *Pygopus lepidopodus* by an Eastern Small-eyed Snake *Cryptophis nigrescens* in New South Wales, *by Danian Michael, Christopher MacGregor, Schiko Okada and David Lindenmayer* 186

ISSN 0042-5184

Front cover: Female *Notoaeschna sagittata* on the banks of the Yarra River. Photo by Frank Pierce.
Back cover: Male *Notoaeschna sagittata* on the banks of the Yarra River. Photo by Frank Pierce.

Does human exposure alter vocalisation rate in Little Penguin *Eudyptula minor*?

C Scarpaci

College of Engineering and Science, Werribee Campus, Victoria University, PO Box 14428, MCMC, Victoria 8001

Abstract
The rate of vocalisations in Little Penguin *Eudyptula minor* was documented to determine whether human presence (handling of penguins), gender and weight influenced vocal production. Observations were conducted during volunteer research nights and a total of 50 penguins were studied at the St Kilda penguin colony. Focal individual penguins were observed for vocal rate continuously within 1 minute focal scans. Rates of vocalisations were documented as rate of vocalisation per penguin and correlated with capture experience, gender and weight. Rates of vocalisation were significantly influenced by capture experience and handling time and suggest vocalisations may be used as a gauge to assess impact (e.g. human presence) across time in avian tourism settings. Levels of tolerance (reducing or ceasing to respond to the stimulus) may be indicative of habituation and such data could be valuable for the management of avian tourism. (*The Victorian Naturalist* **131**(5), 2014, 160-162)

Keywords: penguins, tourism, vocalisation, behaviour

Introduction

Nature-based tourism has experienced exponential growth and seabird tourism is a popular activity (Knight and Gutzwiller 1995). Minimal research is available on the impact that tourism may pose on Little Penguins *Eudyptula minor* found in southern Australia, New Zealand and Chatham Islands. Tourism impact studies assess the behavioural and physiological reactions to stimuli, such as tourism; management protocols that protect wildlife and industry are drawn from the results. Therefore, effective tourism management requires scientists to isolate factors (e.g. reduction in foraging effort) that signal disturbance. This study documents whether the rate of vocalisations that are a signal of disturbance in Little Penguins is dependent on exposure to human handling, gender and weight. The study colony is a resident urban colony of *Eudyptula minor* in St Kilda, Victoria, Australia, which has been exposed to long-term human presence (at least 25 years) due to an active long-term community initiative research group. The study colony provided the opportunity to detect whether behavioural responses to people are influenced by exposure.

Methods

Data on penguin vocalisation was collected from the St Kilda colony from May to September 2004. The St Kilda penguin population was selected based on the available long-term data, ability to collect data simultaneously with Earthcare volunteers and ease of access to the study site. This allowed the researcher to observe vocal behaviour of penguins whilst Earthcare volunteers conducted their research. Earthcare volunteers captured and released penguins after searching randomly for them at various locations on the breakwater. Penguins caught were taken by volunteers to a mobile workstation on the breakwater. The penguins were sexed, weighed and identified via historical tags. Individual penguins that lacked a tag were micro-chipped by a qualified veterinary specialist; for the purpose of this study, penguins were categorised as 'first capture' or 'previously captured'.

The period of time a penguin was handled was measured from the moment the penguin was delivered to the work station until the time it was returned to the site of capture. Data could not be collected from the time of capture due to the numerous volunteers searching for penguins at various locations on the breakwater. The weight of the penguins was divided into four categories—700–1100 g, 1101–1300 g, 1301–1500 g and 1501+ g.

Individual focal animal vocalisations were recorded from the moment a volunteer handled the penguin for data collection of gender, weight and identification at the workstation. The num-

ber of vocalisations produced by each penguin was recorded using continuous observations across a one minute focal scan (Altmann 1974) and recorded onto digital audio tape using a recording microphone. At the onset of the penguin emitting a vocalisation, movement in the beak could be observed. Vocalisations per focal individual was correlated with gender, weight and capture experience. The duration of handling was recorded for each penguin.

A one way analysis of variance (ANOVA) was conducted in accordance with Zar (1999) and significance was determined at $p< 0.05$.

Results

Fifty focal individual penguins (29 females, 21 males) were studied. The majority weighed 1101–1300 g (n = 24) followed by 700–1100 (n = 21), 1301–1500 (n = 3) and 1501+ (n = 2). The maximum number of penguins captured and released per Earthcare volunteer night session was 12 (Mean = 6.25, Range = 0–12, n = 8). The mean time of handling per focal penguin was 149.5 seconds (S.D. = 58.6, Range = 73–333, n = 50). The mean number of vocalisations produced per male penguin per minute was 5.4 (Range = 0–23.7, S.E. = 1.5, n = 21) and for females 3.5 (Range = 0–20.3, S.E. = 0.8, n = 29) with no significant difference ($P = 0.23$) across gender. The mean number of vocalisations produced by weight category was highest in the 1100-1300 g weight but this was not significant across weight categories ($p = 0.305$). The mean number of vocalisations produced per minute was significantly influenced by capture experience and handling time. The mean number of vocalisations produced during the first minute of capture per penguin for first capture was 10.2 (Range= 0–39; S.E. = 3.5, n = 10) and 4.2 (Range = 0–26; S.E. = 0.83, n = 40) for penguins with capture experience ($F = 6.3$, $df = 1$, $P = 0.015$). At the second minute first capture vocal rate was 7.4 (Range = 0-18; S.E. = 2.0, n = 10) and 3.4 (Range = 0–20; S.E. = 0.8, n = 40) for penguins with capture experience ($F = 4.3$, $df = 1$, $P = 0.042$). Rates of vocalisations were found not to be significantly different across capture experience in the third minute ($P = 0.82$).

Discussion

Preliminary findings indicate that rates of vocalisations of Little Penguins across the first two minutes of capture are influenced by capture experience. The higher vocalisation rate in first capture penguins could suggest that capture is perceived as a threat. The response to vocalise may function to: a) startle the perceived threat (human handler); b) attract colony members to the vicinity of the threat to create a chaotic environment that could allow for escape from capture; c) warn kin members of the presence and location of a threat; and d) act as a distress call for support. The lower rate of vocalisations post two minutes may be attributed to: a) lessened threat; b) opportunity for kin members to respond to threat; and c) to conserve energy. Experienced penguins may have learnt through previous captures that human capture is more of a disturbance than a threat, and vocalise to inform kin members of either their locality or presence of handler; but this occurs to a lesser extent than with first capture penguins. This also could indicate that the previously captured portion of the St Kilda penguin colony has become tolerant (a form of habituation) to the presence of people.

Rate of vocal increase in response to a stressor previously has been documented in avian species, e.g. where rates of vocalisations of Mexican Owls increased markedly in the presence of hikers (Swarthout and Steidl 2003) and when simulated recreationists camped within 100 m of breeding eagles (Steidl and Anthony 2000). In another research study, Fowler (1999) demonstrated that exposure to humans influenced the behavioural and hormonal response of Magellanic Penguins in Argentina. Mean number of vocalisations per nest were lower at the tourism site in contrast to an isolated site where the human presence was minimal to none. This indicates that exposure to people could influence behavioural responses, e.g. rates of vocalisations as demonstrated in this study. Minimal research is available on the impact that tourism (or the presence of people) may pose on Little Penguins; however, avian tourism is on the increase. Within the literature available for Little Penguins it is noted that tourism has a detrimental impact through fatalities to eggs and chicks during the breeding season at Middle Island, Victoria (Overeem and Wallis 2003). Little Penguins also have been observed to show intrinsic tolerance to vessel

approach, vibration and engine noise (Higham and Shelton 2011). This study indicates that rate of vocalisation may provide a gauge to assess levels of disturbance to penguins at tourism sites. Tolerance is defined as 'intensity of disturbance that an individual ... tolerates without responding in a defined way' that is demonstrated through empirical observations at a given time across numerous individuals (Bejder *et al.* 2009). The significantly reduced rate of vocalisations by experienced penguins could represent a level of tolerance. Further research should be carried out to assess the applicability of vocalisations in avian species to assess human impact at nesting sites which are exposed to tourism.

Acknowledgement
I am grateful to Earthcare organisers and volunteers for allowing me the opportunity to observe the penguins whilst conducting their research nights.

References

Altmann J (1974) Observational study of behaviour: sampling methods. *Behavior* **49**, 227–267.
Bejder L, Samuels A, Whitehead H, Finn H and Allen S (2009) Impact assessment research: use and misuse of habituation, sensitisation and tolerance in describing wildlife responses to anthropogenic stimuli. *Marine Ecology Progress Series* **39**, 177–185.
Fowler GES (1999) Behavioral and hormonal responses of Magellanic penguins (*Spheniscus magellanicus*) to tourism and nest site visitation. *Biological Conservation* **90**, 143–149.
Higham JES and Shelton EJ (2011) Tourism and wildlife habituation: Reduced population fitness or cessation of impact? *Tourism Management* **32**, 1290–1298.
Knight RL and Gutzwiller KW (1995) *Wildlife and recreationists: coexistence through management and research.* (Island Press: Washington DC)
Overeem RL and Wallis RL (2003) Little penguin *Eudyptula minor* at Middle Island, Western Victoria: current status. *The Victorian Naturalist* **120**, 76–83.
Steidl RG and Anthony RG (2000) Experimental effects of human activity on breeding bald eagles. *Ecological Applications* **10**, 258–268.
Swarthout ECH and Steidl RG (2003) Experimental effects of hiking on breeding Mexican owls. *Conservation Biology* **17**, 307–315.
Zar JH (1999) Biostatistical Analysis. (Prentice-Hall Inc: Englewood Cliffs, New Jersey)

Received 22 August 2013; accepted 27 February 2014

A limited vegetation survey of Cocoparra National Park and Cocoparra Nature Reserve

Eric Whiting

6 Cypress Street, Leeton NSW 2705

Abstract
A vegetation survey of the Cocoparra National Park and Cocoparra Nature Reserve completed in 1992-96 was partially repeated during 2004 and 2005 with 26 of the original sites being re-surveyed. Cryptogams were collected in the 2004-05 surveys and some soil analyses were completed. Sites surveyed covered 14 of the 16 vegetation units in the area. Two hundred and eight vascular plants were recorded and included 43 introduced species. These numbers compared well with those of the earlier surveys; 41 species recorded in the 2004-05 survey were not recorded in the earlier survey and 48 species recorded in the 1992-96 survey were not found in the later survey. Twenty-three mosses, 13 liverworts and hornworts and 47 lichens were recorded in the 2004-05 survey. (*The Victorian Naturalist* **131** (5) 2014, 162-176)

Keywords
Cocoparra Ranges, vegetation survey, bryophytes, lichens

Introduction

The Cocoparra Ranges are part of a series of low ranges and rocky sandstone scarp ridges that lie along the eastern boundary of the south-western alluvial plains of New South Wales (Fig. 1). These outcrops are separated from each other and from the western foothills of the Dividing Range by alluvial valleys. Being less accessible and on poorer skeletal soils, they have retained a covering of natural vegetation in a landscape substantially modified by agricultural use.

Most of the Cocoparra Ranges between Griffith and Rankins Springs was declared as a Nature Reserve (CNR) in 1963, in the northern half, and as a National Park (CNP) in 1969, in

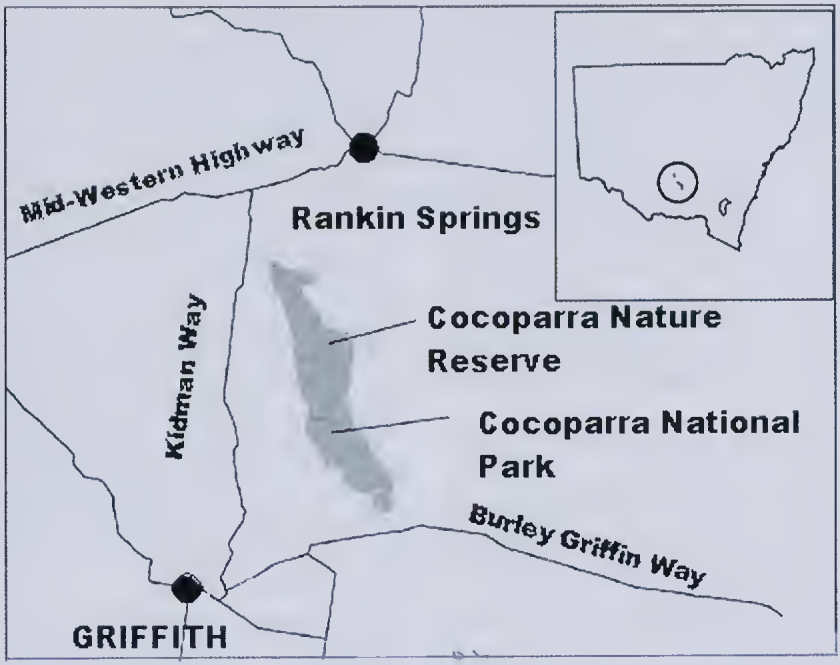


Fig. 1. Location of Cocoparra Nature Reserve and Cocoparra National Park in south-western NSW.

the southern half, to conserve a significant part of this landscape.

Prior to the 1990s, there was little information on the vegetation of the outcrops (Norris and Thomas 1991). A list of plant species was available for Cocoparra National Park (NPWS, Griffith Office, no date) and a vegetation map based on structural form, as interpreted from 1965 aerial photos of CNP and CNR, was drawn by John Brickhill in 1976. At the time, verification of the vegetation by field work was limited. A full survey of the two areas was undertaken in 1992–96 to verify the structural vegetation map, to classify the plant communities, and to obtain information relevant to pest species control programs (Whiting 1997).

During the 1992–96 survey, the average rainfall was c. 420 mm per year (Bureau of Meteorology, taken from Yenda for the period 1925 to present and Binya for the period 1876 to 2012. www.bom.gov.au). Subsequently, the climate changed to an El Niño pattern with continued drought years. Vegetation changed noticeably (pers. obs. over several visits) so a decision was made in 2004 to repeat the original survey and document any changes in vegetation. The survey was extended to include cryptogams and surface soil characteristics.

Cryptogams have been termed the 'Forgotten Flora' in Australia. The term is particularly justified in inland areas despite the fundamental role that soil crust organisms play in preventing soil erosion (Rogers and Lange 1972; Eldridge 1996; Eldridge and Tozer 1997; Eldridge *et al.* 2000). Lists of cryptogams, or even of the major component taxa, are rare, and more rarely published. Easily available distribution data are, therefore, woefully inadequate. Lepp and Curnow collected specimens in 1995 from four sites in the CNP for the Australian National Botanic Gardens Herbarium (now Australian National Herbarium), at Woolshed Flats, Woolshed Bluff, Jacks Creek and Mt. Caley (Curnow pers. comm. 2011). Elix collected a few specimens in the Rankins Springs area at the north end of the Cocoparra Ranges in 1990 (Chapple pers. comm. 2011). Eldridge collected in 1995 and 1996 at two sites in the CNP at Spring Hill and Jacks Creek (Eldridge pers comm. 2011) and McPherson, Cuddy and

Porter collected in 2002 from three sites at Mt Bingar in the CNP, on the west side of the CNP and in the adjacent Binya State Forest (Chapple pers. comm. 2011). *Hyperphyscia isidiata*, a lichen species new to Australia, recently was reported from two sites around Rankins Springs (Rogers 2011). Eldridge also has collected in the nearby Griffith area, the Murrumbidgee Irrigation Area and in Bunganbil State Forest in the Narrandera Ranges to the south of the Cocoparra Ranges. A systematic or comprehensive survey of cryptogams has never been undertaken for the Cocoparra National Park and Cocoparra Nature Reserve.

Methods

Location and surveying sites

The 1992–96 survey sites were not permanently marked. Positions of 35 sites surveyed in 1992–93 were recorded only as estimates on topographic maps. The 70 sites surveyed in 1996 were recorded as GPS readings; however, accuracy was never better than ±50 m with the technology then available. Relocation, therefore, relied on matching vegetation structure data within an area of 1 ha or greater. At a few sites, memory of distinctive features helped in the relocation.

Twenty-two of the 26 sites in the 2004–05 survey were within metres of the original sites of the 1992–95 survey, or at least in the general area. Four sites in the latter survey were considered either too disturbed or simply could not be located, so replacement sites were sampled within the same vegetation community as occurred in the earlier survey, although the vegetation was considered structurally different.

In the 2004–05 survey, sites were not permanently marked, but photographs were taken and a sketch map made of each to aid any future visits.

Vascular flora

As in the 1992–96 survey, each site constituted a 20 m × 20 m quadrat with the following data collected on both occasions: physical data—altitude; slope; aspect; topography; azimuth of horizon for eight compass points; drainage; rock outcropping; basic lithology; and evidence of fire: vegetation data—structural height with cover abundance (Braun-Blanquet scale) for dominant species; a species list with abundance; and estimate of maturity of canopy.

Cryptogam flora

Within each quadrat, samples of bryophytes and lichens were collected from nine c. 1 m^2 areas, four from near the corners, four from near the sides and one from near the centre of the quadrat. Collections of saxicolous lichens were restricted to those on pebbles or small stones. Except for a few readily identifiable taxa that were easily identified in the field, all specimens were identified at my work station at home using a stereo dissecting microscope (ISSCO SZM-3TL) and a compound microscope with a magnification up to 400x (ISSCO BM-Lab). Lichen substances were identified using spot tests for K, C, and Pd only (White and James 1985).

Many specimens of crustose lichens were either sterile or had immature ascospores and were not able to be identified. In addition, several of the taxa of this group do not have published keys for Australian species and the taxonomy is in a state of flux.

Identification and Nomenclature

Identification and nomenclature of vascular flora follows the *Flora of New South Wales* (Harden 1990–93).

Identification keys used for cryptogams were from *Flora Australia* (vols. 54, 55, 56A, 56B and 57 for lichens and vol. 51 for mosses) where appropriate. Otherwise, taxa were identified from published works (Scott and Stone 1976; Catcheside 1980; and Meagher and Fuhrer 2003 for mosses and liverworts, and Filson and Rogers 1979 for lichens). Nomenclature follows Streimann and Klazenga (2002) for mosses, McCarthy (2003) for liverworts and hornworts, and McCarthy (2003; including online amendments up to 2010) for lichens.

Soil tests

One surface soil sample was taken from each quadrat (except, inadvertently, one quadrat) and assessed for texture (after Northcote 1979), pH (Manutec Soil pH Test Kit), and colour (Munsell 2000).

Results

Relocating sites

Fourteen of the 16 vegetation units (Table 1) occurring in the area were sampled in this survey. A Grey Box Low Woodland (unit 1b) and the distinctive Broombush community (unit

5) were not examined, both occurring in more remote regions of the Nature Reserve and at higher altitudes. Only one site was examined in each of seven of the vegetation units, two sites within each of four units (2a, 4d, 6a and 6c), three sites within unit 4e, and four sites within each of units 2b and 6b. Sampling effort did not reflect distribution of vegetation units.

Number of vascular plant species recorded

From the 26 sites, 208 species and subspecies were recorded in the 2004–05 survey, including 43 introduced species (Table 2). These figures are comparable to the totals from the same sites in the previous survey (225 species with 37 introduced). This similarity is apparently coincidental, as 41 species recorded in the 2004–05 survey were not recorded in the same 26 sites in 1992–96, and 48 species were not recorded in the 2004–05 survey but were in the former survey. Such vegetation change was more notable when individual vegetation units were considered. For example, vegetation unit 1a had 50 species that were not recorded in the 1992–96 survey but were recorded in the later survey and 28 species that were not recorded in the 2004–05 survey were recorded in the 1992–96 survey. The four sites in vegetation unit 2b had 26, 26, 25, and 40 species respectively that were not recorded in the 1992–96 survey but were present in the later survey, and 8, 29, 28, and 26 species respectively that were not recorded in the 2004–05 survey but were present in the earlier survey. For these four sites, a species recorded in one survey often was absent in the other survey. For each site, the number of species recorded in both surveys was less than the number of species occurring in only one of the surveys.

Species occurring in only one of the surveys mostly were herbaceous or semi-shrub to small-shrub species that are annuals, biennials or ephemeral in growth habit. Some trends were discernible within some families. The species gained were predominantly by members of the Asteraceae. The Poaceae, Juncaceae and Cyperaceae lost a greater number of species over the time period between surveys than they gained (7, 3 and 4 species compared to 5, 1 and 0 species).

Cryptogams

Twenty-three species of mosses, 13 species of liverworts and hornworts and 47 species of lichens were recorded and identified at least to genus level from the 26 sites. The number of sites was insufficient to establish any clear patterns of distribution or preferences for particular vegetation units. The additional information gathered from opportunistic observations by the author between 1998 and 2002 also failed to elucidate any patterns. Instead, the impression was that occurrence has a greater dependence on microhabitats than any correlation with vascular flora communities.

Soil sampling

Most of the sites were of sandy loam or clayey sand, with other sites varying slightly from these two types (Table 1). Likewise, the pH of the soils mostly was in the range of 4.5 to 5.5 with only two sites as high as 6.0 (in vegetation unit 1a and one gully site in vegetation unit 6b). Soil colour was determined in the dry state. A sample was not collected from the site in vegetation unit 1b.

Discussion

Changes in the vascular flora

The canopy dominants *Eucalyptus populnea*, *E. dwyeri*, *Callitris glaucophylla* and *C. endlicheri* are all slow-growing species and well adapted to semi arid conditions. The assumption was made on trying to relocate the sites that there would be little change in mature trees. It is unclear whether the recorded changes in vegetation structure were due to the natural maturing–decaying–regeneration cycle, the adverse affect of the drought that occurred between surveys, or the heterogeneity of the vegetation units. Only regular observations of identifiable trees over a period of time covering drought and non-drought conditions could give the answers.

The taller shrubs *Acacia doratoxylon*, *Acacia homophylla*, *Acacia deanei* and *Allocasuarina verticillata* are considered to be dis-climax species in the region, with life spans of 30 to 50 years. They are all early dominants after disturbance such as bushfires. Generally, they have shown declines in cover abundance with some becoming absent in the 2004–05 survey. From this, and later observations by the author as the

Table 1. Summary of description of Vegetation Units.

Unit	Definitive characteristics	Soil description
1a	Low open Box woodlands of flat ridgetops, mostly *Eucalyptus populnea* and *Callitris glaucophylla* woodlands with an understorey of *Acacia deanei* and *Calytrix tetragona* located in the western parts of the Nature Reserve north from Woolshed Flats.	Sandy clay loam with pH 6.01 and a red-brown colour.
1b	Low open Box woodlands of the level ridgetops, mostly *Eucalyptus microcarpa* and *Callitris endlicheri* with a sparse understorey including *Acacia decora*.	No information.
2a	Open woodlands of level ridgetops with gravel surface, mostly *Eucalyptus populnea* and *Acacia homalophylla* with sparse understorey.	Clayey loam–sandy to sandy loam with pH 5.0 and a light brown to strong brown colour. Surface characteristically covered with buckshot gravel.
2b	Box woodlands of the alluvial aprons and river terraces, mostly *Eucalyptus populnea* and *Callitris glaucophylla* with an understorey of mostly *Chrysocephalum semipapposum*.	Clayey loam–sandy to clayey sand or sandy loam with pH 5.0 to 5.5 and a brown to red-brown colour.
2c	Box woodlands of alluvial aprons, mostly *Eucalyptus populnea* and *Callitris glaucophylla* with *Eremophila* or *Myoporum* in understorey located around Spring Hill Picnic Ground and eastwards.	Clayey sand with pH 5.5 and a brown colour.
3	Remnant Box woodlands largely cleared. Occasional remaining *Eucalyptus populnea* with regenerating *Acacia deanei*. Introduced grasses, *Echium plantagineum* and *Marrubium vulgare* frequent.	Clayey sand with pH 5.5 and a dark red-brown colour.
4a	Low grassy woodlands of the western slopes, mostly *Eucalyptus dwyeri*, *Callitris glaucophylla* and *Acacia doratoxylon*, understorey mainly *Thyridolepis mitchellii*. Located between Homestead and Store Creeks.	Clayey loam–sandy with pH 5.5 and a light yellow–brown colour.
4b	Low grassy woodlands, mostly *Eucalyptus dwyeri*, *Callitris glaucophylla* and *Acacia doratoxylon*; understorey of *Calytrix tetragona* in patches with *Leptospermum divaricatum* and *Lomandra patens* located on the western slopes north from Homestead Creek.	Sandy loam with pH 5.0 and a dark brown colour.
4c	Woodlands to low woodlands of upper sheltered slopes, with *Eucalyptus dwyeri*, *Callitris endlicheri* and *Acacia doratoxylon*; understorey sparse to moderately dense. *Amphipogon caricinnatus* common in northern parts.	Sandy loam with pH 4.5 and a brown colour.
4d	Low woodlands or low open woodlands mostly on steeper slopes in south and around Woolshed Creek, mostly *Eucalyptus dwyeri*, *Callitris endlicheri* or *C. glaucophylla*, and *Acacia doratoxylon*. Understorey moderately dense with only *Leptospermum divaricatum* in northern valleys.	Clayey sand with pH 4.5 to 5.0 and brown to dark brown in colour.
4e	Woodlands, low woodlands or low open woodlands of the slopes to open ridgetops, mainly with *Eucalyptus dwyeri* or *E. sideroxylon*, together with *Callitris endlicheri*, *Acacia doratoxylon*, *E. microcarpa* and *E. macrorhyncha*. Understorey dense with *Leptospermum divaricatum* and/or *Calytrix tetragona*. *Acacia paradoxa* often prominent.	Sandy clay-loam, a sandy loam or a clayey sand with pH 4.5 and brown to dark brown in colour.
5	Shrubland of *Melaleuca uncinata* with occasional *Allocasuarina verticillata* or *Allocasuarina havilandioranum* or dense with *Calytrix tetragona* and *Acacia paradoxa* on ridgetops or upper gullies.	No information.
6a	Woodlands of the upper sheltered slopes mainly of *Eucalyptus dwyeri*, *Callitris glaucophylla* and *Acacia doratoxylon*. *Acacia deanei* often as mid-storey. Understorey sparse (*Leptospermum divaricatum* and *Calytrix tetragona* absent). Located from Mt Elliot to Pleasant Valley.	Clayey sand with pH 4.5 and very dark brown in colour.
6b	Woodlands of sheltered gullies, mainly *Eucalyptus dwyeri* or *E. populnea* with *Callitris endlicheri* or *C. glaucophylla*, *Acacia deanei* or *Acacia doratoxylon*, *Eucalyptus blakelyi* or *E. melliodora*. Understorey sparse.	Clayey sand to sandy loam or loamy sand with pH 4.5 to 5.5 and either a brown to dark brown colour or yellow-red.
6c	Woodlands to open forests of steep slopes, south facing or under cliff faces, mainly *Eucalyptus dwyeri* with *Callitris endlicheri* and *Allocasuarina verticillata*. Understorey of mainly *Leptospermum divaricatum* scattered around rock outcrops.	Sandy loam with pH 4.5 to 5.0 and brown to dark brown in colour.

Table 1. cont'd.

Unit	Definitive characteristics	Soil description
6d	Woodlands of deep gullies or gorges mainly *Eucalyptus macrorhyncha* and *Callitris endlicheri* with *E. dwyeri* and *Acacia deanei*. Understorey moderately dense and mixed.	Sandy loam with pH 5.5 and a brown colour.

Table 2. List of species recorded from the 2004–05 survey. * indicates introduced species.

	Vegetation unit														
	1a	2a	2b	2c	3	4a	4b	4c	4d	4e	6a	6b	6c	6d	Number of veg. units
Number of quadrats surveyed (n=26)	1	2	4	1	1	1	1	1	2	3	2	4	2	1	14
Vascular plants															
Pteridophyta															
Aspleniaceae															
Pleurosorus rutifolius													x		1
Ophioglossaceae															
Ophioglossum lusitanicum		x	x												2
Sinopteridaceae															
Cheilanthes sieberi	x	x	x			x	x	x	x	x	x	x	x	x	12
Gymnospermae															
Cupressaceae															
Callitris endlicheri	x		x			x			x	x	x	x	x	x	9
Callitris glaucophylla	x	x	x	x	x		x	x				x			8
Monocotyledonae															
Anthericaceae															
Arthropodium minus	x	x	x		x		x	x			x	x	x		9
Dichopogon fimbriatus	x		x					x				x			4
Thysanotus patersonii		x				x	x		x	x			x	x	7
Tricoryne elatior	x					x									2
Asphodelaceae															
Bulbine bulbosa			x			x	x				x	x			5
Bulbine semibarbata	x	x	x	x	x			x	x		x	x	x		10
Colchicaceae															
Wurmbea dioica		x	x								x	x			4
Hypoxidaceae															
Hypoxis glabella		x	x									x	x		4
Juncaceae															
Juncus filicaulis												x			1
Lomandraceae															
Lomandra filiformis		x	x							x	x	x			5
Lomandra multiflora												x			1
Lomandra patens	x					x			x				x		4
Orchidaceae															
Caladenia caerula			x						x	x		x		x	5
Caladenia fuscata		x	x				x	x	x	x		x	x	x	9
Caladenia stellata							x								1
Caladenia tentaculata		x	x				x			x	x	x	x	x	8
Calochilus robertsonii													x		1
Diuris pardina						x	x		x	x		x	x	x	7
Microtis unifolia		x	x			x	x						x	x	6
Pterostylis mutica		x	x				x	x	x	x	x	x		x	9
Pterostylis nana		x	x				x			x		x	x	x	7
Pterostylis sp. aff. *biseta*									x						1
Thelymitra pauciflora	x					x							x	x	4
Poaceae															
*Aira cupaniana											x				1
*Aira elegantissima	x												x		2

Table 2. cont'd.

	Vegetation unit														Number of veg. units
	1a	2a	2b	2c	3	4a	4b	4c	4d	4e	6a	6b	6c	6d	
Amphipogon caricinus	x							x							2
**Avena fatua*			x												1
**Bromus rubens*	x														1
Danthonia eriantha	x	x	x			x						x			5
Elymus scaber											x				1
**Hordeum leporinum*	x												x		2
**Lolium perenne*	x											x			2
Monachather paradoxa						x									1
Poa sieberana	x							x		x		x	x		5
Polypogon monspeliensis	x														1
Stipa bigeniculata	x														1
Stipa densiflora		x							x	x	x	x	x		6
Stipa scabra	x		x	x	x	x		x		x	x	x	x		10
Thyridolepis mitchelliana	x					x	x	x			x	x			6
**Vulpia myuros*	x					x					x	x	x	x	6
Phormiaceae															
Dianella longifolia				x								x	x		3
Dianella revoluta										x		x	x		3
Stypandra glauca													x		1
Dicotyledonae															
Amaranthaceae															
Ptilotus spathulatus	x	x	x								x	x			5
Apiaceae															
Daucus glochidiatus	x	x	x		x		x	x	x	x	x	x	x	x	12
Hydrocotyle callicarpa			x							x		x		x	4
Hydrocotyle laxiflora			x									x			2
Platysace lanceolata										x			x		2
Trachymene cyanopetala		x	x				x	x	x		x	x	x		8
Trachymene ornata						x		x	x		x	x	x		6
Asteraceae															
Actinobole uliginosa		x	x		x		x	x							5
**Arctotheca calendula*	x	x	x	x	x						x	x	x		8
**Aster subulatus*					x										1
Brachycome gracilis			x												1
Brachycome lineariloba		x	x							x					3
Brachycome perpusilla													n		1
Bracteantha bracteata	x		x			x			x		x	x			6
Bracteantha viscosa									x	x			x		3
Calotis cuneifolia			x					x	x			x	x		5
Calotis hispidula	x	x	x				x	x	x		x	x			8
**Carthamus lanatus*	x														1
Cassinia laevis													x		1
Chrysocephalum apiculatum	x	x			x	x	x	x				x			7
Chrysocephalum semipapposum	x	x	x						x	x		x	x		7
**Cirsium vulgare*	x		x						x			x			4
Cotula australis			x		x										2
**Cotula bipinnata*												x			1
Cymbonotus preissianus			x	x								x			3
Gnaphalium sphaericum	x											x			2
**Hedypnois rhagadioloides*	x			x											2
Hyalosperma semisterile						x	x					x			2
**Hypochaeris glabra*	x	x	x		x				x	x	x	x	x	x	10
**Hypochaeris radicata*												x			1
Isoetopsis graminifolia	x	x	x			x	x	x			x				7
**Lactuca serriola*		x	x												2
**Leontodon taraxacoides*											x				1
Microseris lanceolata							x								1
Millotia myosotidifolia		x	x				x	x	x		x	x	x		8

Table 2. cont'd.

	Vegetation unit													
	1a	2a	2b	2c	3	4a	4b	4c	4d	4e	6a	6b	6c	6d	Number of veg. units
Minuria leptophylla		x													1
Myriocephalus rhizocephalus		x					x								2
Podolepis arachnoidea	x	x	x			x	x	x	x		x	x	x		10
Rhodanthe corymbiflora			x												1
Rhodanthe diffusa			x										x		2
Rhodanthe laevis		x	x				x	x	x	x	x	x		x	9
Rhodanthe pygmaea		x	x				x								3
Senecio glossanthus												x			1
Senecio hispidulus													x		1
Senecio quadridentatus									x				x		2
**Silybum marianum*					x										1
**Sonchus asper*													x		1
**Sonchus oleraceus*	x		x	x	x				x	x	x	x	x	x	10
Stuartina muelleri	x	x	x		x		x	x	x	x	x	x	x	x	12
Triptilodiscus pygmaeus	x	x	x					x	x		x	x	x		8
Vittadinia cuneata											x	x			2
Vittadinia dissecta			x									x			2
Vittadinia gracilis		x													1
Bignoniaceae															
Pandorea pandorana									x		x				2
Boraginaceae															
**Echium plantagineum*	x		x	x	x							x			5
Brassicaceae															
**Capsella bursapastoris*			x												1
Harmsiodoxa blennodioides		x	x		x							x			4
**Sisymbrium erysimoides*	x		x	x								x			4
**Sisymbrium irio*			x		x							x			3
Stenopetalum lineare			x												1
Campanulaceae															
Wahlenbergia communis	x		x		x										3
Wahlenbergia gracilenta	x		x						x						3
Wahlenbergia gracilis			x									x			2
Wahlenbergia stricta	x		x			x			x		x	x	x	x	8
Caryophyllaceae															
**Cerastium glomeratum*			x												1
**Silene nocturna*											x	x			2
**Stellaria media*			x		x										2
Casuarinaceae															
Allocasuarina verticillata						x	x					x	x		4
Chenopodiaceae															
Chenopodium desertorum subsp. *anidiophyllum*				x	x							x			3
Chenopodium desertorum subsp. *microphyllum*			x		x							x			3
Einadia hastata			x									x			2
Einadia nutans		x	x	x	x							x			5
Enchylaena tomentosa			x									x			2
Maireana enchylaenoides												x			1
Salsola kali					x										1
Sclerolaena diacantha												x			1
Clusiaceae															
Hypericum gramineum	x														1
Convolvulaceae															
Convolvulus erubescens	x														1
Crassulaceae															
Crassula colorata				x							x				2
Crassula decumbens											x				1
Crassula sieberiana	x	x	x		x		x	x	x	x		x	x		10

Table 2. cont'd.

	Vegetation unit														
	1a	2a	2b	2c	3	4a	4b	4c	4d	4e	6a	6b	6c	6d	Number of veg. units
Dilleniaceae															
Hibbertia sericea										x					1
Droseraceae															
Drosera peltata												x		x	2
Epacridaceae															
Astroloma humifusum		x	x							x		x			4
Melichrus urceolatus		x	x				x		x	x	x	x	x	x	9
Euphorbiaceae															
Phyllanthus fuernrohrii								x							1
Phyllanthus occidentale									x						1
Poranthera microphyllum								x							1
Fabaceae															
Glycine canescens	x														1
Glycine clandestine											x	x			2
Glycine tabacina	x														1
Indigofera australis							x				x	x			3
**Medicago minima*			x	x											2
**Medicago polymorpha*			x		x										2
**Medicago truncatula*	x														1
**Trifolium arvense*	x		x								x				3
**Trifolium campestre*	x														1
**Trifolium glomeratum*	x														1
**Trifolium subterraneum*			x	x											2
Fumariaceae															
**Fumaria capreolata*			x												1
**Fumaria muralis*		x	x									x			3
Geraniaceae															
Erodium crinitum	x	x	x	x	x	x		x	x		x	x			10
Geranium retrorsum												x			1
Goodeniaceae															
Dampiera lanceolata						x			x						2
Goodenia cycloptera		x										x			2
Goodenia fascicularis			x				x					x			3
Goodenia glabra						x	x	x							3
Goodenia pinnatifida												x			1
Goodenia pusilliflora	x	x	x			x									4
Scaevola spinescens	x														1
Velleia paradoxa								x				x			2
Haloragaceae															
Gonocarpus elatus		x	x			x	x	x	x	x	x	x	x	x	11
Lamiaceae															
**Marrubium vulgare*				x	x							x			3
Prostanthera nivea						x									1
Loganiaceae															
Mitrasacme paradoxa		x					x	x		x		x	x	x	7
Malvaceae															
Malva parviflora					x										1
Sida corrugata			x		x							x			3
Sida cunninghamii	x										x	x			3
Mimosaceae															
Acacia deanei			x		x							x			3
Acacia decora														x	1
Acacia doratoxylon						x	x	x	x	x	x		x		7
Acacia homalophylla		x													1
Acacia paradoxa			x									x			2
Myoporaceae															
Eremophila glabra	x														1

Table 2. cont'd.

	Vegetation unit														
	1a	2a	2b	2c	3	4a	4b	4c	4d	4e	6a	6b	6c	6d	Number of veg. units
Myrtaceae															
Calytrix tetragona										x				x	2
Eucalyptus blakelyi			x												1
Eucalyptus dwyeri		x	x			x	x	x	x	x	x	x	x		10
Eucalyptus macrorhyncha										x				x	2
Eucalyptus melliodora			x		x										2
Eucalyptus populnea	x	x	x	x								x			5
Eucalyptus sideroxylon			x							x		x			3
Leptospermum divaricatum								x	x	x		x	x	x	6
Melaleuca erubescens										x					1
Oxalidaceae															
Oxalis perennans		x	x	x	x	x	x	x	x	x	x	x	x		12
Oxalis radicosa				x		x		x	x		x	x	x		7
Pittosporaceae															
Bursaria spinosa													x		1
Pittosporum phylliraeoides			x												1
Polygonaceae															
Rumex brownii			x		x							x			3
Portulacaceae															
Calandrinia eremaea	x	x	x	x	x	x	x		x		x	x	x		11
Primulaceae															
**Anagallis arvensis*		x	x									x			3
Proteaceae															
Grevillea floribunda										x			x		2
Hakea tephrosperma		x		x											2
Persoonia curvifolia										x				x	2
Ranunculaceae															
Ranunculus pachycarpus			x											x	2
Ranunculus sessiliflorus			x		x							x	x		4
Rhamnaceae															
Pomaderris cocoparrana													x		1
Rosaceae															
**Aphanes australiana*			x									x			2
Rubiaceae															
Asperula conferta	x							x		x	x		x		5
**Galium aparine*			x		x							x			3
Galium gaudichaudii			x						x		x	x	x	x	6
Rutaceae															
Eriostemon brevifolius	x					x			x						3
Geijera parviflora	x														1
Phebalium obcordatum									x	x		x			3
Santalaceae															
Exocarpos cupressiformis		x							x						2
Sapindaceae															
Dodonaea viscosa subsp. *cuneata*												x			1
Scrophulariaceae															
Parentucellia latifolia	x														1
Solanaceae															
Nicotiana suaveolens												x			1
Solanum ferocissimum							x								1
Stackhousiaceae															
Stackhousia monogyna		x	x	x						x		x			5
Sterculiaceae															
Brachychiton populneus	x														1
Thymelaeaceae															
Pimelea linifolia	x					x						x	x		4

Table 2. cont'd.

	Vegetation unit														
	1a	2a	2b	2c	3	4a	4b	4c	4d	4e	6a	6b	6c	6d	Number of veg. units
Urticariaceae															
Parietaria debilis			x	x							x	x	x		5
Urtica urens			x		x										2
Violaceae															
Hybanthus monopetalus						x		x	x		x	x			5
Cryptogams															
Mosses															
Acaulon integrifolium			x	x					x	x				x	5
Barbula calycina	x	x	x		x	x	x	x	x	x	x	x			11
Bryum argentium			x						x						2
Campylopus clavatus		x	x				x	x	x	x		x	x	x	9
Campylopus introflexus		x	x			x			x	x			x	x	7
Ceratodon purpurescens	x	x	x		x					x	x	x	x		8
Didymodon torquatus		x	x	x											3
Eccremidium arcuatum	x	x	x		x		x			x	x	x	x		9
Eccremidium pulchellum	x	x	x			x	x	x				x			7
Entosthodon apophysatus	x	x	x			x	x		x		x	x	x	x	10
Entosthodon subnudus subsp. *gracilis*								x						x	2
Ephemerum cristatum			x									x			2
Fissidens taylori	x	x	x				x				x	x	x	x	8
Fissidens tenellus		x													1
Gemmabryum pachytheca	x	x	x		x	x	x	x		x		x			9
Gigaspermum repens	x	x	x			x					x				5
Grimmia laevigata		x			x				x	x	x		x		6
Pleuridium nervosum	x	x	x			x					x	x	x		7
Polytrichadelphus magellanicus												x	x	x	3
Rosulabryum billarderi											x	x	x		3
Rosulabryum campylothecium	x	x	x	x		x	x	x	x		x	x	x	x	12
Triquetrella papillata	x		x	x							x	x	x		6
Weissia controversa		x	x								x	x	x	x	6
Liverworts and Hornworts															
Asterella drummondii	x	x	x		x	x	x	x		x	x	x	x	x	12
Cephaloziella hirta	x	x	x				x				x	x	x	x	8
Fossombronia sp.	x	x	x		x	x	x	x		x	x	x	x	x	12
Gongylanthus scariosus	x	x	x			x	x						x		6
Lethocolea pansa	x	x	x			x				x		x	x	x	8
Phaeoceros laevis		x													1
Riccia bifurca		x	x									x			3
Riccia crinita	x	x	x				x								4
Riccia crystallina							x								1
Riccia lamellosa			x									x			2
Riccia nigrella	x		x		x							x			4
Riccia sorocarpa	x	x	x		x		x								5
Targionia hypophylla													x		1
Lichens															
Fruticose															
Cladia aggregata	x	x	x			x	x	x		x	x	x	x	x	11
Cladia corallazion	x						x	x		x			x	x	6
Cladonia cervicornis													x		1
Neophyllis microlemma									x			x			2
Siphula coriacea							x								1
Teloschistes sieberiana				x								x			2
Thysanothecium scutellum														x	1
Usnea scabrida subsp. *elegans*											x				1

Table 2. cont'd.

	Vegetation unit														
	1a	2a	2b	2c	3	4a	4b	4c	4d	4e	6a	6b	6c	6d	Number of veg. units
Squamulose															
Collema sp.		x													1
Endocarpon sp.	x	x	x		x						x				5
Placidium pilosellum	x														1
Toninia sp.	x	x	x		x							x			5
Crustose															
Acarospora sp.					x										1
Aspicilia contorta												x			1
Caloplaca sp.		x			x	x			x	x	x	x	x		8
Carbonea sp.			x												1
Diploschistes ocellatus	x	x													2
Diploschistes scruposus			x									x			2
Diploschistes sp.		x	x				x				x				4
Lecanora sp.									x						1
Micarea sp.		x						x			x				3
Rhizocarpon geographicum					x				x	x					3
Trapelia coarctata			x												1
Foliose															
Heterodea beaugleholei	x	x	x			x		x	x	x	x	x		x	10
Heterodea muelleri	x		x				x		x	x	x	x		x	8
Punctelia borreri				x							x				2
Punctelia subrudecta												x			1
Xanthoparmelia amphixantha	x														1
Xanthoparmelia barbatica	x	x									x				3
Xanthoparmelia bungendorensis											x				1
Xanthoparmelia elixii					x			x	x	x					4
Xanthoparmelia exillima					x		x				x				3
Xanthoparmelia flavescentireagens					x						x		x		3
Xanthoparmelia flindersiana		x													1
Xanthoparmelia glabrans	x	x				x		x		x	x		x	x	8
Xanthoparmelia incerta							x								1
Xanthoparmelia metastrigosa											x				1
Xanthoparmelia neorimalis	x									x				x	3
Xanthoparmelia pseudoamphixantha	x	x					x	x							4
Xanthoparmelia pseudohypoleia													x		1
Xanthoparmelia remanens								x							1
Xanthoparmelia subcrustacea		x					x			x					3
Xanthoparmelia substrigosa							x				x				2
Xanthoparmelia taractica							x	x		x			x		4
Xanthoparmelia tasmanica									x			x			2
Xanthoparmelia versicolor													x		1
Xanthoparmelia sp.		x													1

drought progressed, it can be seen that at least the older shrubs are susceptible to drought.

Allocasuarina verticillata may have benefited from reduced competition early in the progress of the drought but soon showed a lack of fruiting, then dieback. Since it is the main source of food for the threatened Glossy Black Cockatoo, there was considerable concern for the survival of the small population of this threatened species in this area.

Acacia deanei is the only wattle in the region with true (i.e. bipinnate) leaves. It was seen to decline overall and was clearly affected where it has had a major role in recolonising the cleared areas around the fringes of the Ranges.

Most of the medium-sized shrubs, such as *Acacia paradoxa*, *Persoonia curvifolia*, *Grevillea floribunda*, *Dodonaea* species and subspecies, also showed a general decline in cover abundance. It is possible that these shorter life-

spanned species suffered as much from an absence of viable recruitment as from death of the existing plants.

Acacia paradoxa was noted as very common around the Mount Binger Trig Point in 1993 and entirely dominant as the middle structural layer at site 23 (approximately 200 m SE of the Trig Point) such that the setting out of the quadrat was extremely difficult. In 2005 the bushes were recorded as dead. At the time, drought was thought to be the cause.

Pomaderris cocoparrana has a short but prolific flowering period. A dense stand is a striking sight in the bush, much like the massed flowering of some wattles. The 1996 survey of site 35, 'Oscars Gully', coincided with the flowering of the *Pomaderris* there and was a memorable sight. The sparsity of bushes found during the 2005 survey was very noticeable. *Pomaderris* was also a noticeable component of the shrub layer around the Bingar Trig Point but sadly hard to find in the latter part of the 2000–10 decade. Again the decline has been attributed to drought although, recently, *Pomaderris* has been suggested as being a bushfire-stimulated species (David Egan pers. comm. 2011).

Calytrix tetragona and *Leptospermum divaricatum* appear to be somewhat more resistant, although it was the easier movement through the *Leptospermum* scrubs that prompted the awareness that drought was causing a major change in the habitat. It is surmised that, initially, new growth and leaves were shed after the shortened growing season at the time the surveys took place, giving a later appearance of dieback.

The situation for the herbs and smaller shrubs is much more complicated. It is not known how populations change from year to year, regardless of changes in climate. Is there a cycle of different species rotating according to nutrient utilisation or can species exist in one site year in year out? As outlined above, a small shift in location of a quadrat can give different results due to the heterogeneity of the vegetation.

Relationship of vegetation units and soil characteristics

The paucity of data for each vegetation unit restricts the validity of the relationships that can be inferred, and the summary of soil characteristics for each vegetation unit as given in Table 1 is tentative and requires further investigation.

Cryptogams

Due to drought conditions and the early desiccation of the herbaceous flora, the combined survey was limited to 26 sites. This was insufficient to establish any clear patterns of distribution of the cryptogam flora. The additional information gathered from casual observations also failed to elucidate distribution patterns. Rather, the impression was that occurrence has a greater dependence on microhabitats rather than any correlation with vascular flora communities.

Table 3 lists the species recorded by Lepp and Curnow, Eldridge and Elix that are not recorded in this survey. The species recorded by Lepp and Curnow and also by Eldridge are listed as only by Lepp and Curnow because the list supplied by Eldridge included both sets without annotation.

Suggestions for further work

Although the survey was not able to show the effects of drought conclusively, it did highlight the need for further work to study the vegetation over a long period of time. Such work will require better site recognition via photographs or sketch maps of the sites where sites are not permanently marked. Survey intervals need to be shorter—ideally every 3 to 5 years. As droughts cannot be predicted reliably, a project may have to run for decades. Under current funding schemes, long-term projects have difficulties in being accepted. It would be useful if projected surveys could be done as part of a teaching course in ecology. Although participants would change from year to year, steps could be taken to maintain recording consistency. The outcomes of extended studies would be a greater understanding of the life cycles and ecology of species, particularly herbs and shrubs in semi-arid environments. This will be invaluable for restoration or rehabilitation work in the future.

Cryptogams are poorly reported from inland New South Wales, resulting in very incomplete distribution data. In the Cocoparra Ranges there is still need for further work, especially on crustose and other saxicolous lichens.

Table 3. Other cryptogams recorded in the Cocoparra Ranges.

Species	Source
Mosses	
Bartramia hampei	Lepp and Curnow
Bryum dichotomum	Eldridge
Campylopus bicolor	EW incidental observation between 2000 and 2003
Daltonia splachnoides	EW incidental observation between 2000 and 2003
Dawsonia longiseta	EW incidental observation between 2000 and 2003
Ditrichum difficile	EW incidental observation between 2000 and 2003
Entosthodon productus	Eldridge
Fabronia australis	EW incidental observation between 2000 and 2003
Fissidens curvatus	EW incidental observation between 2000 and 2003
Fissidens leptocladus	Eldridge
Fissidens linearis	Lepp and Curnow
Funaria hygrometrica	Eldridge
Goniomitrium acuminatum subsp. *enerve*	Eldridge
Grimmia pulvinata	EW incidental observation between 2000 and 2003
Hedwigia ciliata	Eldridge
Leptobryum pyriforme	Eldridge
Philonotis sp.	Lepp and Curnow
Polytrichum commune	EW incidental observation between 2000 and 2003
Ptychomitrium australe	Lepp and Curnow
Rosulabryum torquescens	EW incidental observation between 2000 and 2003
Stonea oleaginosa	Eldridge
Thuidium furfurosa	EW incidental observation between 2000 and 2003
Tortula atrovirens	Eldridge
Tortula pagorum	Eldridge
Tortula antarctica	EW incidental observation between 2000 and 2003
Tortula papillosa	Eldridge
Weissia brachycarpa	Eldridge
Weissia rutilans	Eldridge
Liverworts	
Anthoceros sp.	EW incidental observation between 2000 and 2003
Chiloscyphus semiteres	EW incidental observation between 2000 and 2003
Fossombronia wondraczekii	Lepp and Curnow
Frullania prohosciphora	EW incidental observation between 2000 and 2003
Lophochloa squamatus	EW incidental observation between 2000 and 2003
Lunularia cruciata	Lepp and Curnow
Phaeoceros carolinianus	Eldridge
Plagiochasma rupestre	Eldridge
Riccardia bipinnatifida	Eldridge
Riccia albida	Eldridge
Riccia crozalsii	EW incidental observation between 2000 and 2003
Riccia spongiosula	EW incidental observation between 2000 and 2003
Riccia vesiculosa	EW incidental observation between 2000 and 2003
Lichens	
Fruticose	
Cladonia sp. aff. *fimbriata*	Eldridge
Cladonia macilenta	Eldridge
Foliose	
Austroparmelina conlabrosa	Elix
Flavoparmelia rutidota	Eldridge
Hyperphyscia isidiata	Elix
Hypogymnia sp.	Lepp and Curnow
Parmelia erumpens	Eldridge
Punctelia subalbicans	Eldridge
Punctelia subflava	EW incidental observation between 2000 and 2003
Xanthoparmelia alternata	EW incidental observation between 2000 and 2003
Xanthoparmelia bellatula	Eldridge
Xanthoparmelia digitiformis	Eldridge
Xanthoparmelia cilifii	Eldridge
Xanthoparmelia filarszkyana	EW incidental observation between 2000 and 2003

Table 3. cont'd.

Species	Source
Xanthoparmelia luteonata	Eldridge
Xanthoparmelia metaclystoides	EW incidental observation between 2000 and 2003
Xanthoparmelia multipartita	Eldridge
Xanthoparmelia pulla	EW incidental observation between 2000 and 2003
Xanthoparmelia reptans	EW incidental observation between 2000 and 2003
Xanthoparmelia subspodochroa	EW incidental observation between 2000 and 2003
Squamulose	
Collema coccophorum	Eldridge
Endocarpon pusillum	EW incidental observation between 2000 and 2003
Endocarpon simplicatum	EW incidental observation between 2000 and 2003
Crustose	
Buellia subcoronata	Eldridge
Caloplaca ferruginea	Lepp and Curnow
Candellariella vitellina	EW incidental observation between 2000 and 2003
Lecidea ochroleuca	Eldridge
Lecidea sp.	EW incidental observation between 2000 and 2003
Ochrolechia sp.	Lepp and Curnow
Peltula zahlbruckneri	Eldridge
Pyrenopsis sp.	EW incidental observation between 2000 and 2003

Acknowledgements

Collections taken for identification and reported here were done under Scientific Licence No. S 10358. Sincere thanks are given to the staff of the Griffith Office of the National Parks and Wildlife Service for access to the areas and for encouragement to do the work. Thanks also are given to the cryptogam staff of the Australian National Botanic Gardens in Canberra, in particular to Heino Lepp and Judith Curnow, to Greg Chapple and the staff of the Royal Botanic Gardens, Sydney for supplying Herbarium records, and to David Eldridge for permission to quote from his Cocoparra observations. Finally I wish to acknowledge Dr Maria Gibson and her colleagues for the advice given to me as an isolated amateur on the presentation of this paper.

References

Bureau of Meteorology website www.bom.gov. au, accessed November 2013.

Catcheside DG (1980) *Mosses of South Australia.* (Academic Press: London)

Eldridge DG (1996) Distribution and Floristics of Terricolous Lichens in Soil Crusts in Arid and Semi-arid New South Wales. *Australian Journal of Botany* **44**, 581–599.

Eldridge DJ and Tozer ME (1997) *A Practical Guide to Soil Lichens and Bryophytes of Australia's Dry Country; Department of Land and Water Conservation, Sydney.*

Eldridge DJ, Semple WS and Koen TB (2000) Dynamics of Cryptogam Soil Crusts in a Derived Grassland in Southeastern Australia. *Austral Ecology* **25**, 232–240.

Filson RB and Rogers RW (1979) *Lichens of South Australia.* (Government Printer South Australia: Adelaide)

Flora of Australia, Volume 51 Mosses (2006)
-Volume 54 Lichens, *Introduction and Lecanorales* 1 (1992)
-Volume 55 *Lichens – Lecanorales* 2, *Parmeliaceae* (1994)
-Volume 56A *Lichens* 4 (2004)
-Volume 57 *Lichens* 5 (2001)
-Volume 58A *Lichens* 3 (2001).
(ABRS and CSIRO: Canberra and Melbourne)

Harden GJ (ed) (1990–93) *Flora of New South Wales.* Vol. 1–4. (NSW University Press: Kensington, NSW)

McCarthy PM (2003) *Catalogue of Australian Lichens.* (ABRS: Canberra)

McCarthy PM (2003) *Catalogue of Australian Liverworts and Hornworts.* (ABRS: Canberra)

Meagher D and Fuhrer B (2003) *A Field Guide to the Mosses and Allied Plants of Southern Australia.* (ABRS and Field Naturalists Club of Victoria: Canberra and Melbourne)

Munsell (2000) *Munsell Soil Color Charts*, Year 2000 Revised Washable Edition. (Gretag Macbeth: New Windsor, New York)

Norris EH and Thomas J (1991) Vegetation on rocky outcrops and ranges in central and south-western New South Wales. *Cunninghamia* **2**(3), 411 - 441.

Northcote KH (1979) *A Factual Key for the Recognition of Australian Soils*, 4 edn. (Rellim Technical Publication: Glenside, South Australia)

Rogers RW (2011) Hyperphyscia, Australian Physciaceae (Lichenised Ascomycota) http://www.anbg.gov.au/abrs/lichenlist/Hyperphyscia.pdf.

Rogers RW and Lange RT (1972) Soil Surface Lichens in Arid and Semi-arid South-eastern Australia. *Australian Journal of Botany* **20**, 197–213.

Scott GAM (1985) *Southern Australian Liverworts.* (Australian Government Publishing Service: Canberra)

Scott GAM and Stone IG (1976) *The Mosses of Southern Australia.* (Academic Press: London)

Streimann H and Klazenga N (2002) *Catalogue of Australian Mosses.* (ABRS: Canberra)

White FJ and James PW (1985) A New Guide to Microchemical Techniques for the Identification of Lichen substances. *British Lichen Society Bulletin* **57**.

Whiting E (1997) Vegetation Survey of Cocoparra National Park and Cocoparra Nature Reserve. Unpublished report for National Parks and Wildlife Service (Griffith Area).

Received 21 June 2012; accepted 22 January 2014

Southern Riffle Darner *Notoaeschna sagittata* (Odonata) in the Bend of Islands, Victoria

Frank Pierce

PO Box 121, Kangaroo Ground, Victoria 3097. Email: jmandfp@bigpond.com

Abstract
The Southern Riffle Darner *Notoaeschna sagittata* (Odonata) has been recorded in the Yarra Catchment, 30 km north-east of Melbourne, a significant extension of the documented range. Teneral adults of both sexes were recorded at least 1.8 km from the riparian habitat of the Yarra. (*The Victorian Naturalist* **131** (5) 2014, 177-179)

Keywords: *Notoaeschna sagittata*, range extension, distance from stream

Introduction

The Southern Riffle Darner *Notoaeschna sagittata* has been recorded in the Bend of Islands, 30 km north-east of Melbourne. Nine adults and 40 exuviae were found between 25 November 2013 and 23 January 2014. These records, in the Yarra Catchment, are a significant extension to this dragonfly's documented range.

Methods

Sightings were opportunistic, as part of the general Odonata and Lepidoptera observations recorded by the author in the area. When a dragonfly was seen it was photographed if possible. The images were then used to identify the species from Theischinger and Hawking (2006) and various websites. No attempts were made to catch any dragonflies by netting or any other means.

Photos were taken with a hand held Canon Powershot SX20is compact digital camera generally set at x39 (x20 optical and x~2 digital; equivalent 35 mm focal length of 1120 mm), at a distance of 1000 mm minimum. Some exuviae that were an inaccessible distance into the river were photographed through a spotting telescope. Super-macro setting was used to photograph exuviae at close range.

Observations

Adults were seen and photographed by the author nine times in the Bend of Islands. Six adults (three male and three female) were near the banks of the Yarra River. Three adults (two male and one female) with some teneral characteristics, were well away from the Yarra with the minimum distance from the river being up to 1.8 km. The Yarra is the closest viable stream for this species (Table 1 and Figs. 1, 4, front and back cover).

Forty exuviae were also found at seven locations along the Yarra. These were typically on the limbs of dead trees which were partly submerged in the river (Table 1, Figs. 2-4).

An additional sighting has come to the attention of the author. Nick Monaghan photographed an adult 50 m from the banks of the Yarra in North Warrandyte, adjacent to the Pound Bend section of Warrandyte State Park, on 26 December 2012 at 37.731°S, 145.207°E. (Nick Monaghan pers. comm. January 2014) This is approximately 7 kms west of the Bend of Islands (20 kms downstream by river) (Life

Fig. 1. Teneral male *Notoaeschna sagittata* at least 1.4 km from the Yarra River.

Table 1. Sighting Details of Southern Riffle Darner *Notoaeschna sagittata* in The Bend of Islands. [1]- Found by Gavin Masters [2]-Dead, partly submerged, tree.

Site	Date	Form	Location	Distance from Yarra Bank	Latitude	Longitude
1a	25/11/2013	Adult m	Small Wetland	Minimum 1.8km to North	37.6861	145.2936
2a	27/11/2013	Exuvia x1	Tree[2] in Yarra	0 m from bank; 1m above water	37.7177	145.285
2b	29/11/2013	Exuvia x1	Tree[2] in Yarra	5 m into river; 1 m above water	37.7177	145.285
3	7/12/2013	Adult m	House Garden	Minimum 1.4 km to West	37.6893	145.3012
4a	8/12/2013	Adult f	Bank of Yarra	0 m from bank	37.7163	145.2863
5a	12/12/2013	Adult m	Bank of Yarra	0 m from bank	37.7145	145.285
4b	12/12/2013	Adult m	Bank of Yarra	0 m from bank	37.7162	145.2864
6a	21/12/2013	Exuvia x1[1]	Tree[2] in Yarra	0 m from bank; 1.5 m above water	37.7104	145.2835
7	29/12/2013	Adult f	Bank of Yarra	8 m landside of bank	37.70366	145.2923
1b	31/12/2013	Adult f	Small Wetland	Minimum 1.8 km to North	37.6859	145.2939
8	5/01/2014	Adult m	Bank of Yarra	3 m landside of bank	37.71394	145.28474
5b	19/01/2014	Exuviae x14	Tree[2] in Yarra	6 m into river; 1 m above water	37.7145	145.285
5c	19/01/2014	Exuviae x9	Tree[2] in Yarra	4 m into river; 1.1 m above water	37.7145	145.285
9	22/01/2014	Exuvia x1	Tree[2] in Yarra	6 m into river; 2 m above water	37.71647	145.28615
10	22/01/2014	Exuvia x1	Tree[2] in Yarra	0 m from bank; 1.8m above water	37.71484	145.2859
11a	23/01/2014	Exuviae x5	Tree[2] in Yarra	3 m into river; 1.2 m above water	37.71181	145.28477
11b	23/01/2014	Exuviae x2	Tree[2] in Yarra	1 m into river; 1.1m above water	37.71181	145.28477
11c	23/01/2014	Exuviae x5	Tree[2] in Yarra	1.5 m into river; 1.0 m above water	37.71181	145.28477
12	23/01/2014	Adult f	Bank of Yarra	40 m landside of bank	37.71266	145.28476
6b	23/01/2014	Exuvia x1	Tree[2] in Rapid	10 m into river; 0.7 m above water	37.7104	145.2835

Unseen website at http://lifeunseen.com/index2_item_7308.php).

Discussion

Notoaeschna sagittata is a riverine species and the female is known to oviposit while totally submerged at rapids (Theischinger and Hawking 2006). There are several sections of rapids along the length of river where the observations were made. Despite many hours of watching various rapids on the Yarra, this ovipositing was not observed.

All observed adults were sexed and the sex ratio (five male, four female) was close to parity, recognising the small sample size and odd number.

It is of interest that both male and female adults, with some teneral characteristics, were recorded at least 1.8 km from the Yarra. Theischinger and Hawking (2006: 4), as part of the Life Cycle outline, comment that 'riverine species appear to move only a short distance, up to 500 m from the stream'.

Teneral characteristics were noted on the three adults observed away from the river, but not on the six adults observed near the river. This is consistent with the post emergence strategy of leaving the riparian habitat until maturity. Perhaps this is to avoid the rigours of courtship competition before gaining full strength and ability to deal with the opposition.

There was no obvious correlation between the number of exuviae found at a location and its distance from any of the rapids on the river. Site 5, at which 23 exuviae were found, was about 50 m downstream of a rapid but other trees in similar locations had none. Some locations with exuviae were much further downstream from any rapids, while others were adjacent to rapids.

It is fortunate that *N.sagittata* exuviae are easily identified, having the epiproct and paraprocts armed with long spines, a spine on the

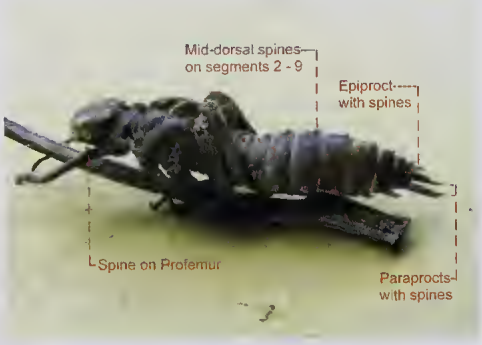


Fig. 2. Exuvia of *Notoaeschna sagittata* found on the banks of the Yarra River.

Fig. 3. Site of Exuvia of *Notoaeschna sagittata* found on the banks of the Yarra River.

profemur and mid-dorsal spines on abdominal segments 2 to 9 (Fig. 2).

The known range of *Notoaeschna sagittata* is documented in Theischinger and Endersby (2009). Most Victorian records are in the far east of the state and none in the catchment area of the Yarra River. A number of records since 2009 have been published for eastern Victoria, but none for the Yarra Catchment (Endersby 2014).

Given the proximity to Melbourne, and the number of sightings over a short period, it is surprising that *Notoaeschna sagittata* has not been recorded previously in the area. 2013/14 may have been a particularly good season. However, the large number of exuviae found indicates that reasonable numbers must have been present in the previous season. The species was not detected, despite regular visits to the area by the author and other known dragonfly enthusiasts over the past few years.

Conservation Status of the Area

In the area of the sightings, the Yarra is flanked by the Bend of Islands on one side and the Mt. Lofty section of Warrandyte State Park on the other. The high quality of the habitat being conserved adjacent to the river will be a contributing factor to the high species diversity in the area. Thirty-two species of Odonata have been recorded in the Bend of Islands by the author since January 2012.

The Bend of Islands is a unique residential conservation area, established in 1976, adjacent to the Yarra River. It is a 634 ha area of high conservation-value bushland, zoned Special Use Zone 2 – Environmental Living (ELZ), in the Shire of Nillumbik. This zoning prohibits the keeping of dogs, cats or other domestic or farm animals, restricts the planting of non-indigenous plants and prohibits the removal of native vegetation without a permit. For more information on the ELZ, refer to the Bend of

Fig. 4. Area map showing Site Number – Adult (A) or Exuvia (E) x number recorded.

Islands Conservation Association website at www.bendofislands.wordpress.com . A dragonfly list for the area is included on this website, along with many lists of other flora and fauna. The three observations that occurred away from the Yarra were on, or immediately adjacent to, the Round the Bend Conservation Co-operative. This is a 128 ha property within the ELZ, owned by 32 shareholders, each with a 0.15 ha house site strategically located to minimise impact on the local bushland, which is of State significance, and includes Box-Ironbark Forest (Refer to www.roundthebend.org.au).

Conclusion

Observation of *Notoaeschna sagittata* in the Bend of Islands is a significant extension of its documented range to include the Yarra catchment. This demonstrates the positive effect of conservation of remnant bushland close to a capital city.

References

Endersby I (2014) Additional Distribution Records for Victorian Dragonflies (Insecta: Odonata). *Victorian Entomologist* 43(4), 99.

Endersby I (2014) Additional Distribution Records for Victorian Dragonflies (Insecta: Odonata). *Victorian Entomologist* 44(2), 36-37.

Theischinger G and Endersby I (2009) *Identification Guide to the Australian Odonata* (Department of Environment, Climate Change and Water NSW: Sydney)

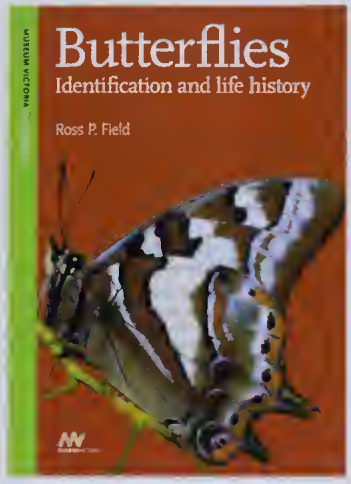
Theischinger G and Hawking J (2006) *The Complete Field Guide to Dragonflies of Australia.* (CSIRO Publishing: Melbourne)

Received 13 February 2014; accepted 24 April 2014

Butterflies: identification and life history

by Ross Field

Publisher: *Museum Victoria Publishing, Melbourne, 2013. ii + 315 pages, paperback.*
ISBN 9781921833090. RRP $29.95



The most recent guide to the butterflies of the state of Victoria was published about 120 years ago—in 1893–94, a two-part compilation entitled *Victorian Butterflies and How to Collect Them* by Anderson and Spry. Thus it is with celebration that Victoria finally has a modern, up-to-date, comprehensive field guide to the butterflies of the state. Most other states of Australia have long had regional guides to their butterfly faunas: South Australia (Fisher 1978); Queensland (Valentine 1988); Tasmania (McQuillan and Virtue 1994); and Western Australia (Hay *et al.* 1994). It is great to see that Museum Victoria has taken the initiative to include this book among the growing list of impressive regional field guides to Australian butterflies.

One hundred and twenty-eight species of butterflies have now been recorded from Victoria, substantially more than the 74 species documented by Anderson and Spry. Of these, 17 species are non-resident (although some of these may enter the state and breed, temporarily). Populations of a further four species (Rock Ringlet, Orange Ringlet, Small Bronze Azure, Eastern Large Bronze Azure) are no longer extant, for reasons that are not entirely clear but probably relate to habitat loss/modification. A staggering 19 taxa have been listed as threatened under the *Flora and Fauna Guarantee Act*, emphasising the heightened conservation concern for these insects.

The stated goal of the book is to 'provide a unique opportunity for enthusiasts and nature lovers to readily identify not only the adult stages, but larvae and pupae that may be encountered in backyards or further afield'. The author hopes that the field guide will be used to identify butterflies and to provide an insight into their ecology, enabling authorities and the general public to be better informed about the environment we live in and manage. In general, these broad objectives are achieved admirably.

The book begins with a series of introductory chapters, which cover aspects of biology, morphological structure of the adult and immature stages, classification, natural enemies, distribution, habitats, study (observing, collecting, preserving, rearing, gardening) and conservation. There is also an important section on how to use the book. This is followed by the species accounts, which are arranged systematically according to modern classification. A checklist of Victorian butterflies, glossary and an index to scientific names and common names complete the work.

The species accounts make up the bulk of the book. Each of the 128 species recorded from within Victoria, plus two additional species that occur just over the border on the Murray River in New South Wales, are depicted over a two-page spread, with the text on the left and illustrations on the right. The text includes notes on identification, larval food plants, biology, habitat and range. The illustrations show the adult butterfly, usually of museum-preserved specimens augmented with photographs of live butterflies taken *in situ*, together with photographs of the egg, larva and pupal stages. In general, the illustrations depicting the adult and immature stages are good to excellent and all are reproduced in colour: the author has clearly opted for quantity rather than quality with more than 1000 images—an impressive feature in itself. Of particular value are the microscopic

images of the embryonic stage, which have been processed using the latest digital software. Another novel aspect is inclusion of illustrations of the larval food plant or habitat, a feature that is notably absent in previous guides.

The inclusion of distribution maps for each species using point data, based primarily on museum collections, is a particular strength. Wisely, the author has divided the data into two time intervals, those records obtained before 1970 and those from 1970 onwards. This is in line with contemporary conservation analysis because records generated before 1970 are far less precise spatially than those obtained in more recent decades. The method also allows for detection of possible changes (e.g. range contraction) in geographical distribution; for example, the spatio-temporal records for the Banded Grass-Skipper and Fiery Jewel suggest that both have now been lost from central Victoria. It would have been useful to distinguish the residents from the vagrants/immigrants that do not breed or rarely breed within the state, and one has to search the text or species checklist to obtain this information. Similarly, records that have been shown to be in error or comprise accidental introductions that failed to establish ought to have been excluded or coded differently on the map, a case in point being the Common Pencilled-blue from Melbourne. Below the distribution map is a phenological chart showing the time of year at which adults have been recorded; a pleasing aspect of this chart is that the months of most frequent occurrence (according to percentage of adult specimens records) are distinguished from those in which adults have rarely been recorded. This is very useful information because it tells you the months when you are most likely to encounter the butterfly; for example, the Varied Sword-grass Brown, which has a long flight period, has most frequently been recorded from November to March, indicating that is the best time of the year to see it.

I found few faults with this book. The author has done well to summarise the vast (and ever expanding) knowledge of and information on Australian butterflies published in the primary scientific literature, and the nomenclature used is up-to-date, although few readers would probably realise that the Golden-rayed Blue (Victoria's only endemic species) was actually described in 2004 rather than in 2000 as indicated in the entry for that species. There is some inconsistency in use of common names in the introductory chapters (e.g. Imperial Blue instead of Imperial Hairstreak, and Wood White instead of Spotted Jezebel). It is advised that data labels of specimens be presented in decimal minutes, but this is a cumbersome coordinate system to use and I would not recommend it (far better to use degrees minutes seconds, or decimal degrees for mapping purposes). The term 'endemism' is used incorrectly in discussing the extent of range-restricted species within each major geographical area of Victoria.

I do have reservations that the book will serve as a primary source for identification, particularly for taxonomically difficult groups (most skippers, some browns, and many blues) because the illustrations of the adults do not provide enough information and diagnostic features by which to distinguish these butterflies clearly. Perhaps my most major concern is that 'Victoria' is omitted from the title! This is a guide to the butterflies found in Victoria, and as such the title is a bit misleading. While it is true that many of these species extend into adjacent states the focus of the work is definitely at the state level.

Dr Field is to be congratulated for assembling this authoritative guide. The book is both attractive and affordable. It should appeal to naturalists, amateur entomologists, students, environmental consultants and conservation planners. The wealth of high quality images in colour reflects the revolution in digital photography and the author's passion for these insects. I have no doubt it will inspire the next generation of butterfly naturalists and entomologists alike.

References

Anderson E and Spry FP (1893–94) *Victorian Butterflies and How to Collect Them.* (H. Hearne & Co.: Melbourne)

Fisher RH (1978) *Butterflies of South Australia.* (Government Printer: Adelaide)

Hay RW, Houston TF, Williams AAE and Williams MR (1994) *Bring Back the Butterflies. Butterfly Gardening for Western Australians.* (Western Australian Museum: Perth)

McQuillan P and Virtue J (1994) *Butterflies of Tasmania.* (Tasmanian Field Naturalists Club Inc.: Hobart)

Valentine PS (1988) *Australian Tropical Butterflies.* (Tropical Australia Graphics: Paluma via Townsville)

MF Braby
Research School of Biology
The Australian National University
Canberra ACT 0200

Coastal guide to nature and history: Port Phillip Bay

by Graham Patterson

Publisher: *Coastal Guide Books, Briar Hill, Victoria. 2013, 172 pages, paperback, illustrations, maps, photographs, ISBN 9780992321703. RRP $30.00*

In just 172 pages, this book presents a remarkable amount of information on the geology, landforms, plants, animals, and history of the coast of Port Phillip Bay. It includes numerous photographs, mostly in colour, along with diagrams, sketches and useful extracts from street maps. An Introduction gives advice to people wanting to walk along the coast, including details about access, safety and tides. A section on Early History deals with Aboriginal sites, exploration and surveying, and the activities of early settlers. There is a page from Gary Presland's *First People* account of a day in the life of Aborigines at Bunwurrung camp, and a summary of William Buckley's 33-year adventure when he lived with indigenous people on and around the Bellarine Peninsula after escaping from the penal settlement at Sorrento in 1803.

A 118-page core section takes the reader on a 260 kilometre clockwise journey around Port Phillip Bay in four stages: Point Lonsdale to Geelong, Avalon to Williamstown, Port Melbourne to Frankston and Mount Eliza to Point Nepean. Within this framework, paragraphs deal with points of interest at successive sites, with illustrations (many pre-2000), documentary extracts (notably on the Western Treatment Plant at Werribee, Royalty arriving at St Kilda in 1901, and the Collins settlement at Sullivan Bay in 1803–04), explanations of place names, natural history and scientific information. Issues considered include the deepening of ship channels, the extinction of Sandridge Lagoon, the renaming of the Black Rock Sandstone as Beaumaris Sandstone, and beach erosion. The accounts are necessarily brief, but the References (p. 165) will guide those seeking more detail.

Another chapter illustrates coastal animals and plants, including birds, dolphins, snails and periwinkles, as well as mangroves and salt marshes, seaweeds and seagrasses, and the components of scrub and woodland. Coastal geology and landforms are considered briefly, and there is a note on coastal management.

Perhaps the instability of Olivers Hill (p. 97) has been influenced by tectonic movements on Selwyn Fault. There is no mention of the fact that the internationally important fossil site in Beaumaris Bay (p. 89) has largely disappeared under reclaimed land at Beaumaris Motor Yacht Club. There is an illustration of 'fossil burrows' at Black Rock Point (p. 86) and the suggestion that these originated because of a kind of 'mud lobster'. There may well be burrow structures in the sandstone here, but the illustrated features have usually been interpreted as fossil wood: flat-lying fragments of twigs, leaves and branches preserved in ironstone with a bark texture similar to that of *Banksia serrata*, a legacy of driftwood stranded on an accreting Mio-Pliocene sandy shore.

The writing is clear and good-humoured, the illustrations well chosen. This is a most useful and thoroughly worthwhile book, which will guide coastal walkers round Port Phillip Bay and stimulate their interest in the features that Graham Patterson describes.

Eric Bird
PO Box 649
Black Rock, Victoria 3193

Reference

Presland G (2010) *First people: the Eastern Kulin of Melbourne, Port Phillip and Central Victoria.* (Museum Victoria Publishing: Melbourne)

Handicapped spiders at Notting Hill, Victoria

On 24 January 2013, within the space of about three minutes, I saw two spiders, each with only five legs, at our house in the Melbourne suburb of Notting Hill.

The first spider, in our bathroom, was a Daddy Longlegs, which had three legs on one side and two on the other (Fig. 1). It moved slowly and laboriously, rolling to one side as it walked. I took it outside and didn't see it again.

When I took the Daddy Longlegs outside, I saw the second spider, a huntsman, which had four legs on one side and one on the other (Fig. 2). It was under the eaves, clearly visible, and generally motionless during daylight hours. I saw a Spider hunting wasp only 3.5 m away, but it didn't find the huntsman on this occasion.

On the morning of 25 January the huntsman had moved about 400 mm to a position near the outer edge of the eaves (Fig. 3). By 7.30 pm AEDT it had moved another 15 mm so that its four left legs were in the evening sun. By 10 pm it had moved about another 4 mm to the very edge of the eaves, with one leg placed on the vertical section of the fascia board.

At 7.50 am on 26 January the spider was still in the same location and position, but when I looked again at 9.15 am it had vanished, probably taken by either a wattlebird or a Spider hunting wasp, both of which live in our garden.

It is not uncommon to see a spider with one or two legs missing, but rather rare to find one with three legs missing (Pasquet *et al.* 2011; pers. obs.). Spiders share the ability to shed appendages—a process known as autotomy, or self amputation—with many other invertebrates and some vertebrates. They shed legs that are grasped by a rival, or grasped or stung by a predator. This enables the spiders to escape danger, but can also be physically costly (Wrinn and Uetz 2007).

Studies of leg loss in two harvestman species *Leiobunum nigripes* and *L. vittatum* (Guffey 1999), a wolf spider *Schizocosa ocreata* (Wrinn and Uetz 2007; 2008) and an orb-weaving spider *Zygiella x-notata* (Pasquet *et al.* 2011) showed that spiders and harvestman species can manage the loss of one or two legs under laboratory conditions. The loss of three, however, can be a serious disadvantage (Guffey 1999), causing such problems as:-

- Reduced mobility
- Loss of fitness
- Loss of balance
- Impact on sensory function
- Reduced ability to catch prey

Fig. 1. Daddy Longlegs with only 5 legs.

Fig. 2. Asymmetrical Huntsman.

Fig. 3. Huntsman, with reduced mobility on only 5 legs.

- Difficulty in escaping from predators
- Reduction in mating success
- Inability to construct a normal web

Some of these problems were not very noticeable in a laboratory environment, but were evident in a simulated natural environment (Wrinn and Uetz 2008).

A spider's ability to cope with leg loss can also depend on which legs are missing. Anne Morton (pers. comm. 2014) has seen a huntsman cope quite well with three legs on one side and two on the other. The huntsman at Notting Hill had lost the first three legs on one side—a much more difficult situation.

The Daddy Longlegs, although having three legs on one side and two on the other, had obvious difficulty in moving as well as loss of balance, while the huntsman, which had lost the first three legs on one side, and which I didn't see move, travelled only a short distance and appeared badly incapacitated. Huntsman spiders normally conceal themselves during the day and hunt at night (Walker *et al.* 2003; pers. obs.). This huntsman could have hidden by moving 400 mm in a different direction, but instead moved to a location where it was both visible and accessible to predators.

Fully grown spiders cannot replace lost legs (Pasquet *et al.* 2011), but if not fully grown, many species can replace lost legs when they moult (however, two or more moults are necessary for full regeneration). I found a macro photography web site (Nicky Bay Photography 2013) describing a wall crab spider *Sianspinops* sp. that lost not only three legs on one side, but its palps as well. Although expected to die, this spider moulted and regenerated its legs and palps. The huntsman at Notting Hill did not seem to be quite fully grown, but would probably have been so after only one more moult, in which case its lost legs would never have fully regenerated.

References

Guffey C (1999) Cost associated with leg autotomy in the harvestmen *Leiobunum nigripes* and *Leiobunum vittatum* (Arachnida: Opiliones). *Canadian Journal of Zoology* 77, 824–830.

Nicky Bay Photography (2013), accessed 26 January 2014. http://sgmacro.blogspot.com.au/2013/07/spider-leg-regeneration.html

Pasquet A, Anotaux M and Leborgne R (2011) Loss of legs: is it or not a handicap for an orb-weaving spider? *Naturwissenschaften* **98**, 557-564.

Walker KL, Yen AL and Milledge GA (2003) *Spiders and scorpions commonly found in Victoria.* (Royal Society of Victoria: Melbourne)

Wrinn KM and Uetz GW (2007) Impacts of leg loss and regeneration on body condition, growth, and regeneration time in the wolf spider *Schizocosa ocreata*. *Canadian Journal of Zoology* **85**(7), 823-831.

Wrinn KM and Uetz GW (2008) Effects of autotomy and regeneration on detection and capture of prey in a generalist predator. *Behavioral Ecology* **19**(6), 1282-1288.

Virgil Hubregtse
6 Saniky Street
Notting Hill, Victoria 3168

Predation of a Common Scaly-foot *Pygopus lepidopodus* by an Eastern Small-eyed Snake *Cryptophis nigrescens* in New South Wales

The Eastern Small-eyed Snake *Cryptophis nigrescens* is a small nocturnal elapid found along the east coast of Australia from Melbourne in Victoria to Cooktown in Queensland (Cogger 2014). During the cooler months of the year, the species frequently shelters beneath exfoliated rocks (Webb *et al.* 2004) and is often found in small aggregations (Scott *et al.* 2013). The Eastern Small-eyed Snake actively forages for food (Webb *et al.* 2003) and is thought to prey principally on small scincid lizards, although it has been reported consuming a variety of other reptile prey in low numbers (Shine 1984). For example, Shine (1984) examined the gut contents of Eastern Small-eyed Snakes from Australian Museum, Queensland Museum, National Museum of Victoria and Australian National Wildlife Collection and found snakes from NSW included prey items such as the Copper-tailed Skink *Ctenotus taeniolatus*, Delicate Skink *Lampropholis delicata*, Garden Skink *L. guichenoti*, Weasel Skink *Saproscincus mustelinus*, *Eulamprus* sp. and a single Mustard-bellied Snake *Drysdalia rhodogaster*. A similar dietary composition was reported for Victorian specimens (Shine 1984). Queensland specimens, however, contained a much broader range of scindid lizards, as well as a Burton's Snake-lizard *Lialis burtonis*, *Ramphotyphlops* sp. and several additional small elapids (Shine 1984). Presumably the dietary breadth of Queensland snakes is due to the greater diversity of species available.

Here we report an instance of predation by the Eastern Small-eyed Snake on the Common Scaly-foot *Pygopus lepidopodus* (Pygopodidae) from Booderee National Park (Jervis Bay Territory). Booderee National Park is located 200 km south of Sydney and 20 km south of the city of Nowra on the south coast of New South Wales, south-eastern Australia (approximate midpoint is 35°10' S, 150° 40' E). The area has a temperate maritime climate with an average rainfall of 1150 mm per annum spread relatively evenly over the year.

On 21 May 2014 at 0940 hours, a male Eastern Small-eyed Snake (snout vent length (SVL) = 511 mm; mass 67 g) was captured between two sheets of corrugated galvanised steel that had been placed within the park for the purpose of monitoring reptiles (see Michael *et al.* 2012 for methodology on using artificial refuges). The snake was placed into a calico handling bag and held overnight as part of a life-history study on the species (Australian National University Animal Care and Ethic Approval No: A2014/02). On 22 May at 0830 hours, the handling bag was opened and on inspection an adult Common Scaly-foot (total length = 315 mm; SVL = 162 mm; mass 21 g) was found to have been regurgitated by the snake (Fig. 1). The nape had obvious signs of necrosis and bite marks were evident along the entire length of the lizard.

The Common Scaly-foot is a diurnal species that actively forages for arthropods (Patchell and Shine 1984; Wall *et al.* 2013), and was presumably captured by the snake during the previous night while the lizard was inactive (maximum and minimum temperature for 20 May was 22.4°C and 16.5°C respectively). The habitat in which the snake was captured is described as an ecotone between dry heathland dominated by Heath Banksia *Banksia ericifolia*, Scrub She-oak *Allocasuarina distyla*, Broad-leaved Drumsticks *Isopogon anemonifolius* and Dagger Hakea *Hakea teretifolia*, and dry forest dominated by Turpentine *Syncarpia glomulifera*. This observation represents the first record of an Eastern Small-eyed Snake preying on a legless lizard in NSW and suggests this species may have a much broader diet than previously thought, possibly including relatively large prey items.

Acknowledgements
This study is supported by the Department of Environment and the Wreck Bay Aboriginal Community.

Fig. 1. A Common Scaly-foot *Pygopus lepidopodus* regurgitated by an adult male Eastern Small-eyed Snake *Cryptophis nigrescens* from Booderee National Park. Photo by D Michael.

References

Cogger H (2014) *Reptile and Amphibians of Australia* 7 edn. (CSIRO Publishing: Melbourne).

Michael DR, Cunningham RB, Donnelly CF and Lindenmayer DB (2012) Comparative use of active searches and artificial refuges to survey reptiles in temperate eucalypt woodlands. *Wildlife Research* **39**, 149-162.

Patchell FC and Shine R (1986) Food habits and reproductive biology of the Australian legless lizards (Pygopodidae). *Copeia* **1986**, 30-39.

Scott ML, Whiting MJ, Webb JK and Shine R (2013) Chemosensory discrimination of social cues mediates space use in snakes *Cryptophis nigrescens* (Elapidae). *Animal Behaviour* **85**, 1493-1500.

Shine R (1984) Reproductive biology and food habits of the Australian elapid snakes of the genus *Cryptophis*. *Journal of Herpetology* **18**, 33-39.

Wall M, Thompson MB and Shine R (2013) Does foraging mode affect metabolic responses to feeding? A study of pygopodid lizards. *Current Zoology* **59**, 618-625.

Webb JK, Brook B and Shine R (2003) Does foraging mode influence life history traits? A comparative study of growth, maturation and survival of two species of sympatric snakes from south-eastern Australia. *Austral Ecology* **28**, 601-610.

Webb JK, Pringle RM and Shine R (2004) How do nocturnal snakes select diurnal retreat sites? *Copeia* **2004**, 919-925.

Damian Michael, Christopher MacGregor, Sachiko Okada and David Lindenmayer

Conservation and Landscape Ecology Group
Long-term Ecological Research Network
Terrestrial Ecosystem Research Network
Fenner School of Environment and Society
Australian National University, Canberra, ACT 0200